

ABSTRACT

Introduction

Rice (*Oryza sativa* L.) occupies a crucial position in the ancient and modern Indian agriculture as well as in the world as it feeds and fulfills the nutritional requirements of 1/3rd of the world's population. Rice is also called as the "Grain of Life", because it is not only the staple food for more than 70 percent of the Indians but also a source of livelihood for about 120-150 million rural households. In order to develop high yielding varieties it is unavoidable for the rice breeders to understand how the grain quality traits are being inherited from their parents to offsprings. Heritability estimates along with genetic advance are generally helpful in predicting the gain under selection than heritability (broad sense) estimates alone (Shreya *et al.*, 2021). Therefore, estimates of GCV, PCV, heritability and genetic advance will play an important role in exploiting future research projections of rice improvement. Grain yield is a complex character, which depends on its several components. These components are further dependent for their expression on several morphological traits, which interrelated with each other showing a complex chain of relationship and also highly influenced by the environmental conditions

(Dhurai *et al.*, 2014). Therefore, the parents selected for the breeding programmes aimed at increased grain yield should possess wide range of genetic variation for the characters.

Material and Methods

The present experiment was carried out at the Field Experimentation Centre of the Department of Genetics and Plant Breeding. The site is located at 25.28 N latitude, 81.54 E longitude and 98 meter above the sea level. It comes under sub-tropical and semi-arid climate. Lies 102 m above sea level. The average annual rainfall is 1042 mm. The present study consists of 20 rice lines along with a check (NDR 359) which were collected from Department of Genetic and Plant breeding, SHUATS were grown in *kharif*, 2021. The experiment was laid in a randomized block complete design (RCBD) with 21 lines in three replications.

Chart 1: List of 20 rice genotypes along with a national check

S. No	GENOTYPES	S. No	GENOTYPES
1	NP 124 8	12	DHAN 50
2	RNR 15048	13	RP BIO 226
3	MTU 1001	14	ANKUR POOJA
4	MTU 1010	15	BPT 5204
5	MTU 1064	16	KNM 168
6	MTU 1224	17	BPT 3291
7	PLA 1100	18	NP 9558
8	KNM 118	19	KPH 376
9	KPH 370	20	SIDHASANNALU
10	DHAN 42	21	NDR 359 (CHECK)
11	DHAN 44		

Total thirteen quantitative traits has been recorded *viz.*, days to fifty percent flowering, days to maturity, flag leaf length, flag leaf width, plant height, number of total tillers, panicle length, number of spikelets per panicle, number of productive tillers, test weight, biological yield,

harvest index and grain yield per plant.

Firstly measure of variability is figured with the aid of Coefficient of variation, which is the ratio of standard deviation of a sample to its mean and expressed in percentage. In the present investigation two types of coefficient of variations were estimated *viz.*, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV).

Coefficient of variation (CV): It is the measure of variability evolved. Coefficient of variation is the ratio of standard deviation of a sample to its mean and expressed in percentage.

$$\text{CV (\%)} = \text{Standard deviation} / \text{Mean X 100}$$

The formulae used to calculate PCV and GCV were stated by **(Burton, 1952)**

$$\text{PCV (\%)} = \text{Phenotypic standard deviation} / \text{Grand mean X 100}$$

$$\text{GCV (\%)} = \text{Genotypic standard deviation} / \text{Grand mean x 100}$$

Heritability calculated by the formula given by **Lush (1949) and Burton and Devane (1953)**. Correlation Coefficient was calculated according to the formula suggested by **Miller *et al* (1958)**. Path coefficient analysis is normally to measures the direct and indirect effects of independent variables on the dependent variables. This technique was firstly used by **Dewey and Lu (1959)**.

Results and Discussion

1. Genetic Variability

1.1 Genotypic Coefficient of Variation (GCV)

High estimates of genotypic coefficient of variation (GCV) were recorded for of grain yield per plant (24.65), harvest index (22.30), test weight (21.58), biological yield per plant (19.94) and flag leaf width (17.85).

1.2 Phenotypic Coefficient of Variation (PCV)

High estimates of phenotypic coefficient of variation (PCV) was recorded for grain yield per plant (26.76), harvest index (23.20), number of spikelet per plant (22.33), biological yield (21.81), test weight (21.60) and number of total tillers (18.74).

The large difference between the GCV and PCV indicate high environmental influence on the expression of particular traits. Relatively low differences were observed between genotypic and phenotypic coefficient of variation for test weight (21.58, 21.60).

1.3 Heritability

Heritability (broad sense) estimated for the thirteen quantitative characters were ranged

from number of days to maturity (55.38) to test weight (99.77). Heritability estimates were high for test weight (g) (99.77), plant height (cm) (96.38), harvest index (92.40) flag leaf width (cm) (92.21), grain yield per plant (84.41), biological yield (83.51), number of productive tillers (73.40), number of spikelet's per panicle (72.29) and panicle length (cm) (72.02). While it was moderate for days to 50% flowering (57.03) and days to maturity (55.38).

1.4 Genetic advance

High genetic advance was recorded for number of spikelet's per panicle (70.47) followed by plant height (cm) (32.35). While moderate genetic advance was recorded for biological yield (24.07), harvest index (23.31), days to maturity (16.92) and grain yield per plant (15.56). Low genetic advance was recorded flag leaf width (0.43), number of productive tillers (3.02), number of total tillers (3.15) and panicle length (4.06).

Similar results were reported by **Saha *et al.* (2019)** for number of grains per panicle; **Nithya *et al.* (2020)** for grain yield per plant and productive tillers per plant; **Umarani *et al.* (2017)** and **Sundaram *et al.* (2019)** for zinc and iron content; **Sandeep *et al.* (2018)** for panicle length; **Amegan *et al.* (2020)** for 1000 grain weight; **Maurya *et al.* (2019)** and **Supriya *et al.* (2017)** for L/B ratio and **Singh *et al.* (2020)** and **Sangamithra *et al.* (2018)** for protein content.

2. Correlation

Genotypic correlation for seed yield per plant showed highly significant and positive association with harvest index (0.909**), biological yield (0.805**), 100 seed weight (0.255**), number of pod clusters (0.796**), number of pods per plant (0.797**), number of primary branches (0.521**). It also showed negative but non-significant association with days to fifty percent flowering (-0.0531), days to maturity (-0.1215), plant height (-0.1588), number of pods per cluster (-0.1466), number of seeds per pod (-0.1407). Seed yield per plant showed significant and positive association with harvest index (0.812**) followed by biological yield (0.721**), number of pods per plant (0.867**), 100 seed weight (0.352*), number of primary branches (0.534*). It also showed negative and highly significant association with days to pod length (-0.485**).negative but non-significant with days to fifty percent flowering (-0.1177), number of seeds per pod (-0.1475), days to maturity (-0.1513). Both the genotypic and phenotypic values are clearly illustrated in Table 1 and 2.

Preliminary studies also revealed the similar results were found in **Mani *et al.* (2018)** and **Maurya *et al.* (2018)** studies, that found significant positive correlation between seed yield and

harvest index, similarly **Bagheri et al. (2011)** found significant positive correlation between seed yield and biological yield.

Table 1: Genotypic correlation among the different traits evaluated in rice during *Kharif*, 2021

	DTF	DM	PH	FLL	FLW	NTT	NPT	PL	BY	HI	NSP	TW	GYP
DTF	1	0.573**	0.2321	0.1995	0.426**	-0.224	-0.2132	0.0745	0.683**	-	0.757**	-	0.1359
DM		1	0.250*	0.1915	0.434**	-	-0.296*	0.385*	0.398*	-	0.386*	-0.1306	-0.1565
PH			1	0.583**	0.2424	-	-	0.519**	0.134	-	0.193	0.1013	-
FLL				1	0.2185	-0.290*	-0.267*	0.176	0.0627	-0.256*	-0.0219	0.1057	-0.249*
FLW					1	-0.1164	-0.1892	0.523**	0.1921	-	0.280*	0.1093	-0.2428
NTT						1	0.929**	-0.1664	-0.248*	0.2441	0.0082	0.1615	0.0537
NPT							1	-0.284*	-0.1802	0.251*	0.0423	0.0395	0.1203
PL								1	-0.1488	-	-0.0495	0.1599	-
BY									1	-0.379*	0.781**	-0.2206	0.419**
HI										1	-0.351*	0.1374	0.670**
NSP											1	-	0.289*
TW												1	0.0001
GYP													1.00

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

Table 2: Phenotypic correlation among the different traits evaluated in rice during *Kharif*, 2021

	DTF	DM	PH	FLL	FLW	NTT	NPT	PL	BY	HI	NSP	TW	GYP
DTF	1	0.550**	0.2184	0.1492	0.401*	-0.150	-0.1434	0.0669	0.613**	-0.384*	0.673**	-0.402*	0.1317
DM		1	0.2451	0.1715	0.408**	-0.36*	-0.261*	0.325*	0.357*	-0.491**	0.310*	-0.1315	-0.1411
PH			1	0.530**	0.232	-0.35*	-0.401*	0.416**	0.1311	-0.494**	0.1649	0.0985	-0.403*
FLL				1	0.1696	-0.25*	-0.252*	0.1347	0.0229	-0.2248	-0.0394	0.1006	-0.2428
FLW					1	-0.05	-0.1184	0.442**	0.1665	-0.430**	0.2442	0.1089	-0.2134
NTT						1	0.929**	-0.1876	-0.0818	0.2455	0.1128	0.1359	0.1744
NPT							1	-0.279*	-0.0425	0.255*	0.1192	0.035	0.2182
PL								1	-0.1534	-0.425**	0.0374	0.133	-0.515**
BY									1	-0.351*	0.672**	-0.2026	0.482**
HI										1	-0.268*	0.1306	0.636**
NSP											1	-0.411**	0.292*
TW												1	-0.0016
GYP													1.00

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

3. Path analysis

Path analysis in particular having the direct effect of seed yield on characters such as harvest index followed by biological yield and number of spikelet's per panicle in descending order.

Phenotypic path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. The path analysis results showed that positive and direct on grain yield were exhibited by harvest index, biological yield, test weight

and flag leaf width. Phenotypic path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. The genotypic path analysis results showed that positive and direct on grain yield were exhibited by number of spikelet's per panicle, number of productive tillers, harvest index and panicle length.

Table 3: Genotypic direct (in bold) and indirect effects of thirteen traits on seed yield in rice evaluated in Kharif, 2021

	DTF	DM	PH	NPB	NPP	NPC	NCP	PL	NSP	100SW	HI	BYP	SYP
DTF	0.2338	0.1341	0.0543	0.0467	0.0996	-0.0525	-0.0499	0.0174	0.1598	-0.0977	0.1771	-0.0976	0.1359
DM	-0.2436	-0.4249	-0.1063	-0.0814	-0.1842	0.1803	0.1258	-0.1635	-0.1693	0.2216	-0.1641	0.0555	-0.1565
PH	-0.1453	-0.1566	-0.6261	-0.3648	-0.1518	0.2694	0.296	-0.3246	-0.0839	0.3231	-0.1209	-0.0634	-0.450**
FLL	0.0225	0.0216	0.0658	0.1129	0.0247	-0.0327	-0.0301	0.0199	0.0071	-0.0289	-0.0025	0.0119	-0.249*
FLW	-0.0804	-0.0818	-0.0457	-0.0412	-0.1886	0.0219	0.0357	-0.0986	-0.0362	0.0883	-0.0528	-0.0206	-0.2428
NTT	0.2699	0.5099	0.5171	0.3479	0.1398	-0.702	-0.824	0.1999	0.2981	-0.2933	-0.0099	-0.194	0.0537
NPT	-0.1537	-0.2134	-0.3407	-0.1922	-0.1364	0.6693	0.7207	-0.2047	-0.1298	0.181	0.0305	0.0284	0.1203
PL	0.0195	0.1008	0.1359	0.0461	0.1371	-0.0436	-0.0744	0.2621	-0.039	-0.1331	-0.013	0.0419	-0.601**
BY	0.0732	0.0427	0.0144	0.0067	0.0206	-0.0266	-0.0193	-0.0159	0.1071	-0.0406	0.0836	-0.0236	0.419**
HI	-0.2835	-0.354	-0.3503	-0.1736	-0.3179	0.1657	0.1705	-0.3446	-0.2573	0.6788	-0.238	0.0933	0.670**
NSP	0.6731	0.3433	0.1716	-0.0195	0.249	0.0073	0.0376	-0.044	0.6944	-0.3118	0.8889	-0.4301	0.289*
TW	-0.2498	-0.0781	0.0606	0.0633	0.0654	0.0967	0.0236	0.0957	-0.1321	0.0822	-0.2896	0.5985	0.0001

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)

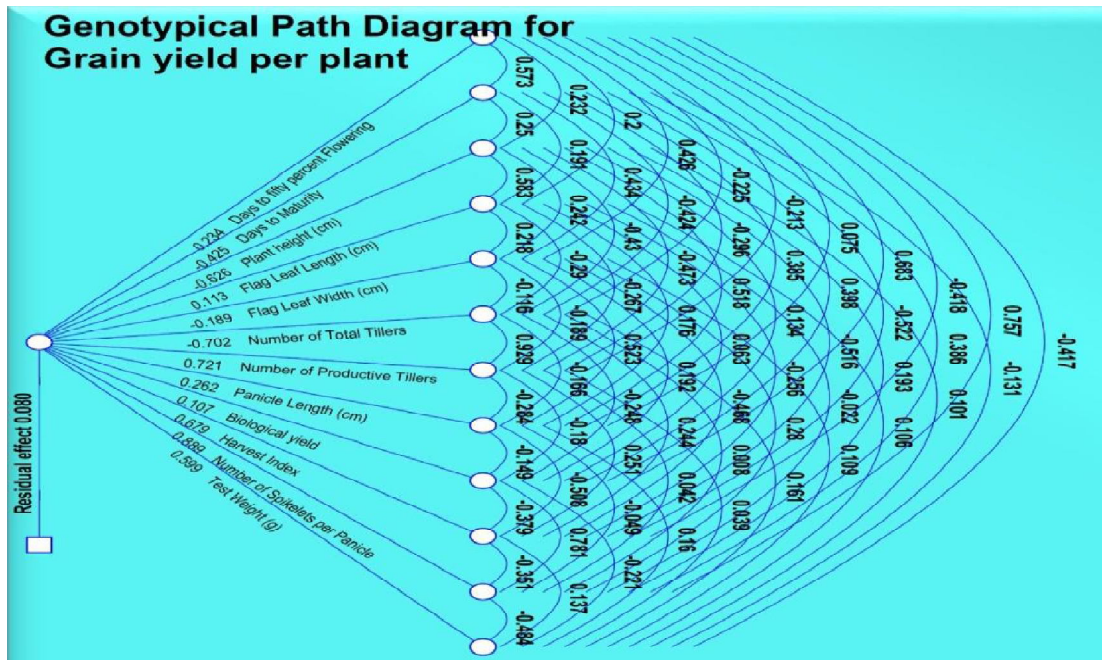
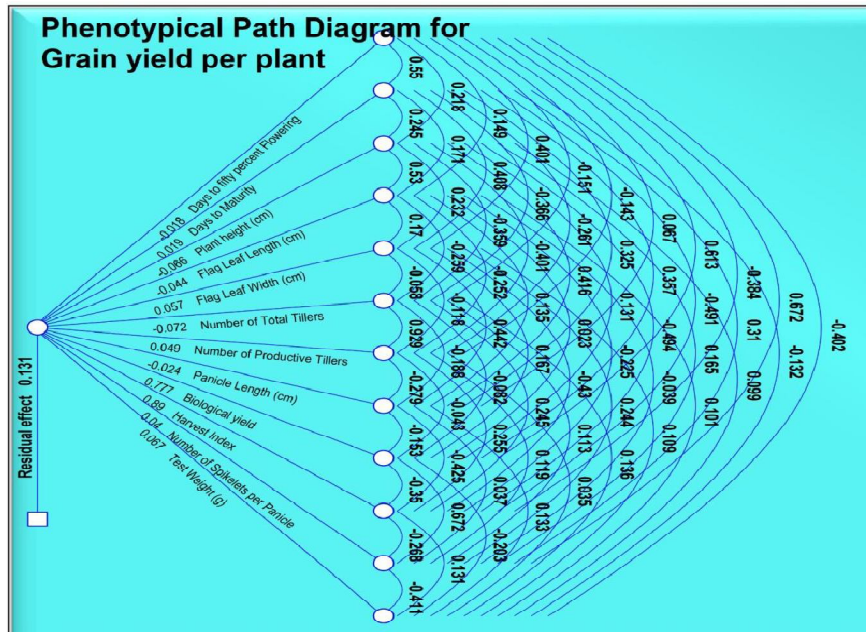


Table 4: Phenotypic direct (in bold) and indirect effects of thirteen traits on seed yield in rice evaluated in *Kharif*, 2021

	DTF	DM	PH	NPB	NPP	NPC	NCP	PL	NSP	100SW	HI	BYP	SYP
DTF	-0.0177	-0.0097	-0.0039	-0.0026	-0.0071	0.0027	0.0025	-0.0012	-0.0109	0.0068	-0.0119	0.0071	0.1317
DM	0.0103	0.0187	0.0046	0.0032	0.0077	-0.0069	-0.0049	0.0061	0.0067	-0.0092	0.0058	-0.0025	-0.1411
PH	-0.0143	-0.0161	-0.0655	-0.0347	-0.0152	0.0236	0.0263	-0.0273	-0.0086	0.0324	-0.0108	-0.0065	-0.403*
FLL	-0.0066	-0.0076	-0.0235	-0.0443	-0.0075	0.0115	0.0112	-0.006	-0.001	0.0099	0.0017	-0.0045	-0.2428
FLW	0.0229	0.0233	0.0132	0.0097	0.0571	-0.0033	-0.0068	0.0252	0.0095	-0.0245	0.0139	0.0062	-0.2134
NTT	0.0108	0.0263	0.0259	0.0186	0.0042	-0.0719	-0.0668	0.0135	0.0059	-0.0177	-0.0081	-0.0098	0.1744
NPT	-0.0071	-0.0129	-0.0198	-0.0124	-0.0058	0.0458	0.0493	-0.0137	-0.0021	0.0126	0.0059	0.0017	0.2182
PL	-0.0016	-0.0078	-0.01	-0.0032	-0.0106	0.0045	0.0067	-0.024	0.0037	0.0102	-0.0009	-0.0032	-0.515**
BY	0.4768	0.2774	0.1019	0.0178	0.1295	-0.0636	-0.0331	-0.1193	0.7774	-0.2725	0.5222	-0.1575	0.482**
HI	-0.3418	-0.4365	-0.4394	-0.2	-0.3826	0.2184	0.2266	-0.3784	-0.3118	0.8897	-0.2382	0.1162	0.636**
NSP	0.027	0.0125	0.0066	-0.0016	0.0098	0.0045	0.0048	0.0015	0.027	-0.0108	0.0402	-0.0165	0.292*
TW	-0.0271	-0.0089	0.0066	0.0068	0.0073	0.0092	0.0024	0.009	-0.0137	0.0088	-0.0277	0.0675	-0.0016

* and ** Significant at P<0.05 and P<0.01, respectively

DTF: Days to 50% flowering, DM: Days to maturity, PH: Plant height (cm), FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: No. of Total Tillers, NPT: No. of Productive Tillers, PL: Panicle length, BY: Biological Yield (g), HI: Harvest index (%), NSP: No. of spikelet per panicle, TW: Test Weight (g), GYP: Grain yield per plant (g)



References

- Amegan, E, Efisuc, A. Akoroda, M, Shittu, A. and Toncgnikcs, F. (2020). Genetic Diversity of Korean Rice (*Oryza sativa* L.) Germplasm for Yield and Yield Related Traits for Adoption in Rice Farming System in Nigeria. *International Journal of Genetics and Genomics*, **8**(1): 19-28.
- Bagheri, N, Babaeian-Jelodar, N. and Pasha, A. (2011). Path coefficient analysis for yield and yield components in diverse rice (*Oryza sativa* L.) genotypes. *Biharean biologist*, **5**(1): 32-35.
- Directorate of Economics And Statistics, (2018-19). Ministry of Agriculture & Farmers Welfare (DAC&FW), Govt. of India; IIIrd Advance Estimate
- Dhurai, S. Y., Reddy, D. M. and Ravi, S. (2016). Correlation and path analysis for yield and quality characters in rice (*Oryza sativa* L.). *Rice Genomics and Genetics*, **7**.
- Dewey, D.R. and Lu, K.H. (1959). A correlation and path coefficient analysis of component of seed production. *Agro. J.*, **51**: 515-518.
- Donald, C.M. and Hamblin, J. (1976). The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Adv. Agron.*, **28**: 61-65.

- Fisher, R. A. (1936).** The Use of Multiple Measurement in taxonomic problem. *Annals of Eugenics*, 7(2): 179-188.
- Lush, J. L. (1949).** Heritability of qualitative traits in farm animals. Proceedings of eight international congresses genetic. *Heidos (Suppl.)* 336-357.
- Mani, B. R., Kumar, B. M. (2018).** Morphological characterization of rice (*Oryza sativa* L.) landraces of the hilly zone of Karnataka. *Indian Journal of Plant Genetic Resources*. 31(3): 328- 331.
- Nithya, N., Beena, R., Stephen, R., Abida, P. S., Jayalakshmi, V. G., Viji, M. M. (2020).** Genetic variability, heritability, correlation coefficient and path analysis of morpho physiological and yield related traits of rice under drought stress. *Chemical Science Review and Letters*, 9(33): 48-54.
- Robinson, H. F., Comstock, R. E. and Harvey, P. H. (1951).** Genotypic & phenotypic correlation in maize and their implications in selection. *Agr. Jou.*, 43: 282-287.
- Saha, S. R., Hassan, L., Haque, A., Islam, M. M. and Rasel, M. (2019).** Genetic variability, heritability, correlation and path analysis of yield components in traditional rice (*Oryza sativa* L.) landraces. *Journal of Bangladesh Agricultural University*, 17(1): 26-32.
- Sandeep, S., Sujatha, M., Subbarao, L. V and Nccraja, C. N. (2018).** Genetic Variability, Heritability and Genetic Advance Studies in Rice (*Oryza sativa* L.). *International Journal of Current Microbiology and Applied Science*, 7(12): 3719-3727.
- Sundaram, K. M., Rajeswari, S., Saraswathi, R. and Jayaprakash, P. (2019).** Genetic variability studies for yield and its Components and quality traits with high iron and zinc content in segregating population of rice (*Oryza sativa* L.). *International Journal of Chemical Studies*, 7(3): 800-805.
- Shreya, D., Deepak, G., Sarawgi, A. K. and Abhinav, S. (2021).** Genetic variability studies for yield and yield components in rice (*Oryza sativa* L.). *The Pharma Innovation Journal*, 10(10): 1057-1059. Burton, G. W., and Devane, D. E. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agr. Jour.*, 45(10): 478-481.
- Maurya, B. K., Chand, P., Tomar, P., Kumar, S., Singh, R. S. S., Singh G. (2019).** Studies on variability and genetic parameters for yield and its contributing traits in rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*, 8(4): 2002-2005.
- Supriya, Anurag, S. and Jaiswal, H. K. (2017).** Genetic variability for quality, yield and yield related parameters in basmati rice (*Oryza sativa* L.). *AGRES An International Journal.*, 6(1) :63-70.

Sanghamitra, P., Sah, R. P., Bagchi, T. B., Sharma, S. G., Kumar, A. and Munda, S. (2018). Evaluation of variability and environmental stability of grain quality and agronomic parameters of pigmented rice (*Oryza sativa* L.). *Journal of food science and technology*, **55**(3): 879-890.

Umarani, E, Radhika, K., Padma, V., Subbarao, L. V. (2017). Variability, heritability and genetic advance for agro-morphological and grain quality parameters in landraces of rice (*Oryza sativa* L.). *Environment and Ecology*, **35**(3): 1682-1687.